Bent (S.)

AN ADDRESS

DELIVERED BEFORE

THE ST. LOUIS HISTORICAL SOCIETY, DECEMBER 10, 1868, AND REPEATED BY REQUEST BEFORE THE MERCANTILE LIBRARY ASSOCIATION, JANUARY 21, 1869.

UPON THE

Thermometric Gateways to the Pole

SURFACE CURRENTS OF THE OCEAN, AND THE INFLUENCE OF THE LATTER UPON THE CLIMATES OF THE WORLD.

By SILAS BENT.

SAINT LOUIS:
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1869.

TO

WILLIAM TOD HELMUTH, M. D.,

FOR HIS

Attainments as a Scholar and his Worth as a Gentleman,

THIS ADDRESS IS INSCRIBED,

BY HIS FRIEND

SILAS BENT.

ADDRESS.

Ladies and Gentlemen:

The subject which it is my intention to introduce for your consideration is not new. It has interested the minds of great men in all nations. It embraces much scientific research, and involves circumstances of interest to the world. It takes us from the equator to the pole. It includes mathematical and nautical calculations—while the winds that blow over the surface of the globe—the currents that, with never ceasing flow traverse the mighty oceans—the climates of various regions of the earth, and the varied temperatures of the waters, are brought before us in our investigations.

Fully impressed with a knowledge of these facts, and especially bearing in mind the comprehensive nature of the subject, it is with many misgivings that I appear before you to discuss this question of "The *Thermometric Gateways to the Pole,*" and were it not that circumstances appear to have conspired for the past thirty years to bring the consideration of such topics in their varied bearings fully before my mind, and to have placed me in a position for proper understanding, thought, study and experience in those matters which essentially belong to a just comprehension of the subject, it would not now be introduced for your consideration.

But other and higher objects than the mere accuracy of my theory—something more elevated than the just and honorable feeling of satisfaction that would, were it to prove correct, certainly belong to him who could claim priority in such an important discovery—has actuated me at the present time, when from various sources I find that Germany, Sweden, France, England and Russia have in contemplation expeditions to the Pole. It is the actual saving of human life—the benefits that will accrue to many departments of science, and the solving of a geographical problem which is now, for the most part, conjectural.

Twenty-five years upon the ocean, in constant intercourse with seamen of all nations, a position as an officer of the United States Navy, a part of whose duty it was to record and compare meteorological observations, an honorable acquaintance with scientific navigators and explorers, are, I trust, sufficient guarantee for the earnestness of my belief in that which I shall endeavor to demonstrate, and which I firmly believe to be true.

THE DOCTRINE OF CURRENTS.

With these few remarks, I shall proceed directly to the consideration of my subject. There is a circulation in the air; there is a circulation in the bodies of all animals; there is a circulation in the ocean—all of which are governed by laws, immutably fixed, and which, in all their modifications and conditions, they rigidly observe and obey.

Place under the microscope the web of a frog's foot, and hither and thither we shall see varied currents of blood crossing and recrossing each other, apparently without order and without law.

Examine the capillary vessels of the human body, and there, in the most tortuous ramification, passes and repasses the life-giving fluid from one set of vessels to the other, to all appearance without any governing cause. Look into the bosom of the mighty deep, either when the storms of heaven are lashing the white topped waves, or when the serene sky is breathing a beautiful calm over the waters—and here seemingly with the utmost incongruity, are currents and counter currents, meeting each other at all variety of angles, above, below, near and far, over the whole surface and depths of the waters.

Further scientific investigation, however, teaches us that, as in the human system one variety of vessels pass from one side of the heart carrying the pure blood to every portion of the body,—that another set of tubes of wonderful conformation carry back the impure blood to the heart, where in obedience to the inexplicable laws of nature, it is sent into the lungs, there to be purified and again to go through the body with its life-giving and healthful influence,—and, moreover, as this purifying process is being accomplished, animal heat is generated: so it is with the currents of the ocean, which it will be my endeavor as briefly as possible to explain.

EQUILIBRIUM OF NATURE.

There is an equilibrium in all nature. There is an unseen power that, while it utterly forbids annihilation of matter, constantly so alters the forms, appearances and uses of the molecules, that loss in one portion of the universe is counterbalanced by a gain in another; and thus, by that inscrutable power of adaptation, the earth revolves within its orbit and the stars sing together in harmony, while the dew upon the blossom, the rain, the ice, the snow, the heat and cold, all conspire to perfect those laws of compensation and adaptation, thus indicating to the student of physical science *that* perfect harmony, law and order in nature, which, to the unitiated, are obscure, incongruous, and undefined.

The sea, the atmosphere, and the sun, are to the earth what the blood, the lungs and the heart are to the animal economy.

The process of evaporation is provided by an all-wise Providence to purify, renovate, and vivify the surface of the globe; and in this great and continually recurring action may be seen one of the causes of those currents which are found in the ocean. Let me here quote to you a single passage, from one of the most scientific and at the same time beautifully written works upon the subjects of which we are now treating. I allude to that on "The Physical Geography of the Sea," by my friend Admiral M. F. Maury. He says: "The mean annual fall of rain on the entire surface of the earth is estimated at about five feet. To evaporate water enough annually from the ocean to cover the earth on the average five feet deep with rain; to transport it from one zone to another, and to precipitate it in the right places, at suitable times and in the proportions due, is one of the offices of the grand atmospherical machine. This water (bear in mind) is evaporated principally from the torrid zone.

"Supposing it all to come thence, we shall have encircling the earth a belt

of ocean three thousand miles in breadth, from which this atmosphere evaporates a layer of water annually sixteen feet in depth. And to hoist up as high as the clouds, and lower down again all the water in a lake sixteen feet deep, three thousand miles broad, and twenty-four thousand miles long, is the yearly business of this invisible machinery."

Now I ask you, understanding as we do the constant effort of nature to restore equilibrium, and the laws of adaptation, what must be the effect upon the ocean of the removal of this immense mass of water of twenty-four thousand miles in length, three thousand miles wide, and sixteen feet in depth? Certainly an endeavor on the part of the water to occupy this enormous space; and to do this, all the waters north and south of this space or zone are at once set in motion to restore the equilibrium; and were there no continents and islands, or inequalities in the bed of the oceans, this flow would be uniform round the whole earth; but by these local obstructions they are divided into many streams and diverted into numerous channel-ways, through which they pour their volumes to form the great equatorial currents of the Atlantic and Pacific.

THE ISOTHERMAL CURRENTS.

By the earth's rotation on its axis, objects on its surface between the tropics are carried from West to East at the rate of a thousand miles an hour, whilst as we advance toward the Poles, this rate decreases in the same proportion as the parallels of latitude decrease in circumference; so that when we arrive at the points where the circumference is only twelve thousand miles, instead of twenty-four thousand as it is at the Equator, this velocity of rotation is but five hundred miles an hour—and so on decreasing, until reaching the Pole.

Now an object set in motion toward the Equator from the Polar regions—where the velocity of rotation is small—will constantly be arriving at points on the earth's surface where the velocity is greater; and not at once acquiring this greater velocity, its direction will tend obliquely to the westward. Hence we find these streams or currents which flow from the Pole toward the Equator, always taking a southwestwardly direction whenever the continents and islands will permit. These streams from the Northern and Southern Hemispheres, meeting at the Equator, form and give direction to the equatorial currents, the waters of which are thrown to the westward; but, interrupted by the continents which lie across their paths, and changed in their specific gravity by the expansive heat of the sun, they throw off hot streams to the north and south, like blood from the heart in the animal system, to carry their life-giving warmth and nourishment along their path to the earth's extremities.

Of these streams, there are two in the Northern Hemisphere and probably three in the Southern. It is only to the former, however, that we have specially to call your attention on this occasion; and these are known as the Gulf Stream of the Atlantic, and Kuro-Siwo of the Pacific. Their striking resemblance, as traced upon the chart, in size, form and direction is apparent to the eye. The Gulf Stream was delineated from observations taken by the United States Coast Survey, under Professor A. D. Bache; and the Kuro-Siwo from observations made upon it by the Japan Expedition, under Commodore M. C. Perry.

To describe the first, I shall again quote from Admiral Maury's "Physical Geography of the Sea," wherein he says:

"There is a river in the ocean. In the severest droughts it never fails; and in the mightiest floods it never overflows. Its banks and its bottom are of cold water, while its current is of warm.

"The Gulf of Mexico is its fountain, and its mouth is in the Arctic Sea. It is the Gulf Stream. There is in the world no other such majestic flow of waters.

"Its current is more rapid than the Mississippi, and its volume is more than a thousand times greater.

"Its waters, as far out as the Carolina coasts, are of an indigo blue.

"They are so distinctly marked, that their line of junction with the common sea water may be traced by the eye.

"Often, one-half of the vessel may be perceived floating in Gulf Stream water, while the other half is in common water of the sea, so sharp is the line, and such the want of affinity between those waters, and such too the reluctance—so to speak—on the part of those of the Gulf Stream to mingle with the common water of the sea. * * * * * * *

"At the very season of the year when the Gulf Stream is rushing in *greatest* volume through the Straits of Florida and hastening North with the *greatest* rapidity, there is a cold stream from Baffin's Bay, Labrador and the coasts of the North, running to the South with equal velocity.

"These two currents meet off the Grand Banks of New Foundland, where the latter is divided. "One part of it underruns the Gulf Stream, as is shown by the icebergs which are carried in a direction tending across its course. * * * The other fork runs between the United States coast and the Gulf Stream, to the South. As a rule, the hottest water of the Gulf Stream is at or near the surface; and as the deep sea thermometer is sent down, it shows that these waters, though still far warmer than the water on either side at corresponding depths, becomes gradually less and less warm until the bottom of the current is reached. There is reason to believe that the warm waters of the Gulf Stream are no where permitted in the oceanic economy to touch the bottom of the sea. There is every where a cushion of cool water between them and the solid parts of the earth's crust. This arrangement is suggestive and strikingly beautiful. One of the benign offices o fthe Gulf Stream is o convey heat from the Gulf of Mexico, where otherwise it would become excessive, and to dispense it in regions beyond the Atlantic, for the amelioration of the climates of the British Islands and all Western Europe.

"Now cold water is one of the best non-conductors of heat, and if the warm water of the Gulf Stream was sent across the Atlantic in contact with the solid crust of the earth—comparatively a good conductor of heat—instead of being sent across as it is in contact with a cold non-conducting cushion of coo water to fend it from the bottom, all its heat would be lost in the first part of the way, and the soft climates of both France and England would be as that of Labrador, severe in the extreme, and ice-bound.

"The maximum temperature of the Gulf Stream is 86 degrees, or about 9 degrees above the ocean temperature due to the latitude. Increasing its latitude 10 degrees, it loses but 2 degrees of temperature; and after having run

three thousand miles toward the North it still preserves, even in winter, the heat of summer.

"With this temperature it crosses the fortieth degree of north latitude, and then, overflowing its liquid banks, it spreads itself out for thousands of square leagues over the cold waters around, and covers the ocean with a mantle of warmth that serves so much to mitigate in Europe the rigors of winter.

"Moving now more slowly, but dispensing its genial influences more freely, it finally meets the British Islands. By these it is divided; one part going into the Polar basin of Spitzbergen, the other entering the Bay of Biscay, but each with a warmth considerably above the ocean temperature.

"We know not, except approximately in one or two places, what the depth or under temperature of the Gulf Stream may be; but assuming the temperature and velocity at the depth of two hundred fathoms to be those of the surface, and taking the well-known difference between the capacity of air and water for specific heat as the argument, a simple calculation will show that the quantity of heat discharged over the Atlantic from the waters of the Gulf Stream in a winter's day, would be sufficient to raise the whole volume of atmosphere that rests upon France and the British Islands from the freezing point to summer heat."

Then, when speaking of the effect on the climates of Central America and Mexico arising from the excess of heat carried off from them by this stream, he says: "A simple calculation will show that the quantity of heat daily carried off by the Gulf Stream from those regions and discharged over the Atlantic, *is sufficient to raise mountains of iron from zero to the melting point, and to keep in flow from them a molten stream of metal greater in volume than the waters daily discharged from the Mississippi river.*"

THE GULF STREAM AND THE KURO-SIWO.

These are brief extracts from what this profound thinker and beautiful writer has said in regard to the Gulf Stream, its character, and influence upon the regions of the globe whose shores are washed by its genial waters; and they are equally applicable to the Kuro-Siwo of the Pacific as they are to the Gulf Stream. The Kuro-Siwo, however, was not known at the time of his writing, and was delineated, as before stated, from the meterological records of the sixteen vessels composing the Japan expedition.

The analogy between these streams is as complete as it is striking. By looking at this chart, on which they are traced, you will perceive that they both spring from the northern edge of the equatorial currents, in latitude 22 degrees north. That they both, at first, start directly north, and then curve gradually to the eastward. That neither of them (except the Gulf Stream at its origin,) touch the eastern shores of America or Asia, but that, after sweeping obliquely across the vast oceans in which they lie, they bathe the western shores of those continents; that, when striking those continents, they are both split into two unequal parts: that the larger portions of each, impinging upon the land, are recurved to the southward, and finally fall again into th currents of the equator; that the smaller portions of both, however, continue their course to the northeast, into the Arctic ocean—that of the Gulf Stream by way of Spitzbergen, and that of the Kuro-Siwo by Behrings Straits: that

they both have cold counter currents intervening between them and the continents near which they rise, and which run in directly opposite directions to their own courses, and with equal rapidity; that they both have the same high temperature of 86 degrees, preserving in the dead of winter the heat of summer; that they are both cushioned in beds of cool water, which, from want of affinity, robs them of none of their warmth; that this warmth, after having been carried thousands of miles through the waters of the oceans, is (the moment these streams touch the land) thrown out with such freedom, and diffused so far, by the conductive power of the earth, as to change the climates of nearly half of both the continents; and that they both, in their never-ceasing and unchanging beneficence, are fit symbols of the wisdom and goodness of Him who "created the heavens," "formed the earth and made it," and "created it not in vain," but who "formed it to be inhabited."

I have compared the circulation of the waters of the oceans to that of the blood of the animal system; but whilst Harvey's discovery revealed the laws which govern the latter, and led to their complete development, we have but glimpses here and there, of those which control the currents of the oceans in their compensating and equalizing ramifications. For, of even those on the surface, but very little is known, only a few of them having been delineated or systematically examined; and of those below the surface, or in the depths of the ocean, we know literally nothing, further than that they do exist and are unchangeable.

POLAR CURRENTS AND ICEBERGS.

The polar currents, which have been described as flowing down to form the great currents of the Equator, mostly underrun the warm waters of the Gulf Stream and Kuro-Siwo, as is shown by the drift of the icebergs in the North Atlantic, which maintain a direction to the southward across the course of the Gulf Stream, until dissolved by the tepid heat of the latter.

To properly understand why these icebergs do not take the course of the Gulf Stream, when they encounter its current, instead of retaining that of the current from the North, it must be remembered that ice floating in salt water has seven-eighths of its volume immersed, and only one-eighth above the surface. An iceberg, then, that rises three hundred feet above the surface of the sea, is submerged to the depth of twenty-one hundred feet; and if the surface current, therefore, is not more than a thousand feet in depth, it will, of course, take the direction of that which may be running beneath it. I have seen an iceberg in the Southern ocean which we estimated to be two miles in diameter, and about seven hundred feet high; consequently its depth below the surface was nearly five thousand feet, and in the heaving swell of a fierce tempest, in which our ship had been struggling for a fortnight, it stood as unmoved in its majestic grandeur as the rock-bound coasts of Cape Horn itself.

THE NORTHWEST PASSAGE.

Having, however, described the two great streams in the North Atlantic and Pacific which have the most direct bearing upon my subject, and traced the flow of large portions of their warm waters to the very threshold of the Arctic sea, I will now, before following them farther, discuss another branch of the subject necessary for the proper elucidation of my theory.

To those whose pursuits of life have not rendered them familiar with nautical science, it may be well to explain the proper signification of certain technicalities, which is necessary to a thorough appreciation of the subject.

First, I must demonstrate what is understood by the "Northwest Passage," in contradistinction to the Passage to the Pole.

Many European nations in early times, accepting the theory of the rotundity of the earth, and seeking for a shorter route to India than that by the way of the Cape of Good Hope, endeavored to sail thence by directing their course westward across the Atlantic. Christopher Columbus entertained this idea, and even after the success of his voyages, believed that he had accomplished the desired result, and died supposing that he had reached the Islands lying off the east coast of Asia. Hence, the name India Islands was given to the group lying at the mouth of the Gulf of Mexico. But after a time, when it was discovered that a vast continent and mighty ocean lay between these India Isles and the shores of Asia, the term "West Indies" was applied to them in contra-distinction to the "East India Islands" found to the southward of the eastern hemisphere. Thus it will appear the continent of America blocked up the western route to India. The route by Cape Horn, besides being more distant, was even more dangerous than that by the Cape of Good Hope, and the idea became prevalent that there might exist and be practicable for commerce, a passage round the northern extremity of America; and this passage lying in a *Northwest* direction from Europe, gave rise to the expression of "Northwest Passage." The first attempt that was ever made to discover or effect this passage was undertaken by John Cortereal, a Portuguese, in the year 1563. *He failed; and so has all the marvelous intelligence, enterprise and energy that have been expended in that direction by every maritime nation of the world, from that time to this.*

SIR JOHN'S FRANKLIN'S EXPEDITION.

The early expeditions, being but poorly provided, and having no succor or supplies to fall back upon—when so unfortunate as to be caught in the ice for the winter—were usually completely destroyed by the scurvy, starvation and intense cold; and that those of the past century have not shared the same fate is, in a great measure, to be attributed to the timely assistance rendered them by other expeditions whenever they have met with disasters.

Of this, we want no more fearful illustration than that afforded us by the terrible fate of Sir John Franklin's party.

This expedition sailed from England in 1844. The vessels—Erebus and Terror—were probably lost in 1845; and notwithstanding the millions of money that have been spent in expeditions of relief, and a heroism of self-sacrificing energy in the personel composing those expeditions, of which the history of the world scarcely affords a parallel—yet the intelligence now comes to us that the American explorer Hall has recently obtained undoubted proof that Capt. Crozier—Franklin's second in command—with several of the men, were still living only some three years ago! Can the mind picture a more frightful fate than the imprisonment of these people for twenty years in such a region of frozen desolation as must have been the scene of their wanderings?

OF OTHER FAILURES.

In addition to the many expeditions made in this direction to the west of Greenland, there have been others equally fruitless, so far as the main object of their enterprise was concerned, that have been sent to the northeast from the Atlantic, to find a route round the North of Europe and Asia to India; and still others, though comparatively few, that have penetrated Behrings Straits with the special purpose of passing either to the east or west—as opportunity might offer—from the Pacific to the Atlantic.

Of these latter, the celebrated Captain James Cook was the first. He made his attempt in 1779, but did not attain a higher point than latitude 70 degrees 29 min. n. long 161 deg. 40 min. w., though the ice which barred his way was loose ice, and not a compact barrier, showing that it was drift ice, brought there by the counter currents or winds, or by both combined, and was temporary. Cook being killed at the Sandwich Islands by the natives, his successor, Captain Clerke, made another attempt during the following summer, but did not reach as high a latitude as Cook.

Kotzebue, of the Russian Navy, made an attempt in 1815 to pass to the West round the Asiatic continent, but was barred by ice; he however says: "*The sea was open to the northeast as far as the eye could see*," and "*that passing rom the American to the Asiatic coast was like passing immediately from summer into winter.*"

Capt. Beechy, in 1826, tried to make a "northeast" passage from Behring's Straits, by clinging to the coast, but got only as far as Cape Barrow. Capt. McClure, also of the British Navy, passed these Straits in 1850, to search for Sir John Franklin, in co-operation with four vessels under Sir Edward Belcher, which were to go northwest from Davis' Straits. Along the low lands of the north ends of the continents, the tides and fresh water from the rivers which flow thence, generally keep open a narrow fringe of water between the ice and the shore, during the summer months; and along this fringe or strip of water, Capt. McClure coasted till reaching the Parry Islands, about longitude 117 deg. west, where his ship was frozen in.

In June 1853, he abandoned his ship, the "Investigator," and with her crew traveled one hundred and seventy miles over the ice to join the "Resolute," which was also frozen in at Dealy Island, and which in turn was abandoned by order of Sir Edward Belcher, and which in September, 1855, was found in Baffin's Bay, latitude 67 deg. N., by a New London whaler, still wedged securely in a field of ice covering an area of hundreds of square miles, with which she had been safely drifted twelve hundred miles to the southward and eastward from the point where she had been abandoned.

The gallant McClure is justly entitled to the distinguished credit of having been the first to pass from ocean to ocean round the continent; yet, even he cannot be said to have *circumnavigated* the north end of the continent, since a part of the passage was made on foot over the ice. The only expeditions that have attempted to reach the Pole, prior to those of this past summer were those of Henry Hudson, in 1607, who reached latitude 81 deg. 30 min. to the northwest of Spitzbergen; of Phipps, in 1773, who only got to latitude 80 degrees 37 minutes north, in the same locality; of Admiral Wrangell, who made an attempt in 1823 by traveling over the ice to the north of

Siberia, reaching latitude 70 deg. 51 min. in longitude 175 deg. 27 min. west, where he saw an open sea, boundless to the vision, toward the Pole; of Captains Buchan and Franklin in 1818, who reached lat. 80. deg. 34 min. north, near Spitzbergen, and then sailed to the westward along the ice barrier, but lost ground (to the southward) as they advanced in that direction till they had to abandon their attempt; and of Parry, in 1827, who on reaching the ice to the north of Spitzbergen, took to his boats, fitted on runners, and after one of the most laborious journeys on record, during which he traveled actually five hundred and sixty-eight miles, yet made only seventy-two miles on his course to the north from the point where the boats left the water, reaching latitude 82 deg. 40 min. 23 sec. north.

DR. KANE AND DR. HAYES.

This was the nearest authentic approach to the Pole, until Dr. Kane's discovery of the open sea to the north of Smith's Sound, in 1854, and of Dr. Hayes, who visited this same locality in 1861, and reached the latitude of nearly 83 deg. But in both of these last two cases, journeys of from one hundred and fifty to two hundred miles, in a straight line, had to be made over the ice, from where the thermometer ranged below zero, before reaching this open sea with its water of a temperature of 36 degrees above zero.

From a careful perusal of all the narratives of those who have made explorations in the Northern seas, we find that many discoveries were made, which more or less have an important bearing upon the subject matter of this lecture, and which will be evident as we proceed in our investigations.

Thus, of the more important were the manner in which the ice, collecting for years, forms an impenetrable barrier in certain localities for hundreds of miles together; that it generally adheres to the shores of the main land and larger islands; that huge fragments are broken off from these accretions by the superincumbent accumulations of snow and by the action of the water, and float off in vast masses and are drifted by the currents to the southward; and glimpses, if not complete discovery, of that open sea which it is now generally believed entirely surrounds the Pole. The most important discoveries to science, however, were perhaps the determination of the north magnetic Pole by Sir James Ross, in 1831, about latitude 70 deg. and longitude 100 deg. west; the verification of two "Poles of greatest cold," one amid the Parry Islands, north of America, in latitude 78 deg. longitude 93 deg. west, and the other north of Asia, in latitude 77 deg. and longitude 103 deg. east; and the discovery of the open sea at the head of Smith's Sound by Dr. Kane's expedition, in 1854, and revisited by Dr. Hayes in 1861—before spoken of.

OLD NOTIONS EXPLODED.

This last does away with the old notion of the accumulated ice of ages, resting upon and around the Pole, which, in fact, in the natural order of things, is a physical impossibility: for, since meteorological observations have shown that the average precipitation of moisture in all parts of the world is five feet annually, and as it is admitted by the most distinguished

arctic explorers that the sun has but little influence in dissolving the ice within those regions, it is fair to suppose that, were there no other influences at work to produce this dissolution, the accretions of ice and snow (from being so much less compact than water) would fully equal this average. This being the case, then, in the period of six thousand years there would have accumulated about the Poles, in an area embracing a million and a half of square miles, a plateau of ice thirty thousand feet in height!

These accumulations of water in a solid form, at the earth's extremities, would not only have materially lowered the level of the uncongealed oceans from whence this moisture had been drawn by evaporation, but would also, by the withdrawal of such a weight from the central zones of the earth and the piling of it up at the extremities, have destroyed the equilibrium or balance of the globe.

There are other agencies, however, besides the direct rays of the sun, constantly at work winter as well as summer, to keep these seas open, and of which we shall speak presently.

OPEN POLAR SEA.

It is to this open sea about the Pole that we believe there can be found, at certain seasons of the year, direct and accessible passages for ships, and of course thence directly to the Pole itself—for it is an interesting fact in regard to this sea, that it has tides which ebb and flow with regularity, showing that it has a great area free from land or other permanent obstructions.

In the transactions of the Royal Society of London in 1675, it is stated that a ship, employed by a party of Dutch merchants to make discoveries in the north, had brought back the wonderful news that "after having sailed to the northeast-ward of Nova Zembla, several hundred leagues between the parallels of 70 and 80 degs., the sea was perfectly open and free from ice." It is also stated, that in 1655, a Dutch whaler sailed in a perfectly free and open sea, to *within one deg. of the Pole*, and that about the same period another one had gone two degs. beyond the Pole. These reports I believe, notwithstanding it is the fashion to treat them as fables. And I believe furthermore, that these vessels succeeded in getting there, simply because they followed by accident one of the very pathways which science now points out to us as affording the only gateways to the Pole. It was thought for centuries that Columbus was the first discoverer of America; but it is now well known that the Scandinavians and Norsemen had been upon this continent nearly five hundred years before he made his voyages. And for three hundred years—or ever since these voyages of the Dutch—explorers of every description, whether national or individual, have been, and are still in my opinion, trying every other avenue but the right ones to reach the Pole and circumnavigate the northern extremities of the continents. The histories of these explorations were a part of my professional reading for upwards of a quarter of a century. The disasters and failures of these expeditions were therefore familiar to me, as they are to every intelligent seaman; but I had never given the subject any special attention or study, until it so happened that the materials were placed in my hands which led to the delineation of the Kuro-Siwo; and then, just as my mind was filled with intense interest at the beautiful harmony and analogy between this magnificent stream and

the system of currents of which it forms a part in the Pacific, with that of the Gulf stream and its system in the Atlantic, the news was received of Kane's discovery of the Open Polar Sea, and people began at once to inquire how such a thing was possible, when it was so well known that a belt of ice several hundred miles in width must surround this sea and lie between it and the Equator. The charts were upon my table, at which I was daily at work, showing the Gulf Stream and Kuro-Siwo as they are now exhibited before you (except the coloring), with their warm branches or forks extending by Spitzbergen and Behrings Straits, and perfectly determined in both their width and direction as far as this ice belt is supposed to exist. Now, applying the axiom in the physical science of the sea, as laid down by Maury, that "whenever a current or stream of water is found flowing *from* any point in the ocean, other streams or currents of equal volume must flow to that point," and knowing that immense currents flowed constantly down from the Arctic ocean by every avenue opening into the Atlantic and Pacific, except along the pathways of these northern forks of the Gulf Stream and Kuro-Siwo, it was almost impossible that the idea should not occur to my mind that these were the streams that not only carried this excess of water to the Pole, but also that the warmth they carried with them was the direct and *sole* cause of this open sea, and that their paths through the ice-belt offer the only highways for ships to that sea; and I so stated it in my official report on the Kuro-Siwo to Commodore Perry. Still impressed with these facts, last summer, when I heard that expeditions were being fitted out in Europe for the Pole, I addressed a communication to the President of the American Geographical Society of New York, which I will now read. You will notice a repetition in the letter of some things which have just been presented to your consideration. This arises from my having given in the former only a general statement of the facts on which I base my theory, whilst this evening they have been described more in detail.

MR. BENT'S THEORY PROPOUNDED.

Where events relating to the cruise of the Preble are referred to, it may be well to mention to you that they transpired in 1848-9, some five years prior to the discovery and delineation of the Kuro-Siwo as an important part of the grand system of oceanic currents of the Pacific—the Japan expedition having originated from the success of the mission of the Preble to Japan:

LETTER TO MR. DALY.

2020 OLIVE STREET,
ST. LOUIS, MO., September 15, 1868.

C. P. Daly, Esq., President American Geographical and Statistical Society, New York:

SIR:—Having seen in the papers a brief telegram that "England and Russia were about fitting out an expedition for the North Pole," and having given the subject some reflection—or rather, having had the subject forced by circumstances upon my mind during past years, I take the liberty of addressing you (as the presiding officer of that society in this country which

will naturally take the deepest interest in the plans adopted by the expedition as to the route it is to pursue), to state that the result of these reflections is the creation of a doubt, in my mind, as to whether former expeditions to the Arctic seas have not pursued a mistaken route, in attempting to go by the way of Baffin Bay instead of Behring's Straits or Spitzbergen; and also whether, if Captain McClure had stood boldly out to the northward and eastward from Behring's Straits instead of hugging the north shore of the continent, he would not have carried an open sea and a warm current with him till reaching the northward of Melville Island, and from thence have had a southerly current with him into the Atlantic.

In other words: whether the expeditions attempting to make the "Northwest Passage" have not gone up stream against a hyperborean current, frigid in its temperature and filled with opposing ice, when, by making the Northeast passage they might have gone down stream and carried with them the genial influence of waters directly from the tropics, and perhaps an open pathway to the very Pole itself.

To enable you to understand the process by which my mind was drawn gradually to this subject, and the conclusions which have been the result, it may not be amiss to enter somewhat into details. These I shall endeavor to put into such a shape as to be readily followed and as little tiresome as possible; but, before doing so, will premise by saying that the duties of a naval officer necessarily oblige him to be more or less observant of the currents of the ocean, as well as of the various other meteorological phenomena by which he is constantly surrounded; yet it is not always the case that the phenomena presenting themselves within the scope of any one person's experience, lead to either complete results, or furnish even sufficient data upon which to base a reasonable hypothesis—and whether such has not been the case in this instance, I, with much diffidence, submit this paper to your indulgent patience and judgment to decide.

At the close of the Mexican war in 1848, the U. S. ship Preble, to which I was attached as sailing master or navigator, was ordered from California on special service to China. In crossing the Pacific ocean we stopped at the Sandwich Islands, where we found a large number of American whalers assembled for the winter. In conversation with one of the most intelligent of these captains, he told me he was just from a cruise in the Arctic ocean, and that in pursuit of whales, he had gone *"several hundred miles to the northward and eastward from Behring's Straits, and three hundred miles beyond the limits of his chart, and with an open sea still before him as far as could be seen in that direction."* From the Sandwich Islands we kept between the tropics, to avail ourselves of the northeast trade winds, and also to take advantage of the equatorial current—the latter of which we found setting to the westward at the rate or from thirty to eighty miles per day, and which, spreading from the tropic of Cancer to that of Capricorn, has a width as great as that of the whole Atlantic Ocean.

I had before crossed this current some eight or ten times, at various seasons of the year, and therefore knew, from personal observation, that it is as constant in its flow to the westward as that of the equatorial current in the Atlantic.

A few months after our arrival in China, intelligence was received from the Governor General of Java that a number of shipwrecked American seamen were in prison at Nagasaki, in Japan, and the Preble was ordered to proceed there at once and endeavor to obtain their release.

This was in mid-winter, when the northeast monsoon was at its height; when no vessels but steamers or opium clippers attempted to make passages to the north coast of China.

The almost universal prediction of both Americans and Englishmen at Hong Kong was, that the Preble could not accomplish the voyage at that season of the year; but, with genuine pluck, the captain always replied that she should do so or else lay her bones in the bottom of the China sea. I mention this to show how unknown were the dangers, and how unfrequented the seas at that time, lying between the southern coast of China and Japan.

As soon as we got out of port we encountered the full force of, not only the monsoon, but also, in a measure, that of the southerly current which flows constantly down the Formosa channel, and which is so strong that sailing vessels cannot beat to windward against it, but are obliged to run out to the eastward of Formosa, to take advantage of a current setting to the northward from that point.

Contending against the first of these currents, the Preble was ten or twelve days reaching the south end of Formosa, although the distance is only about two hundred and fifty miles. So soon as she doubled the south end of the island, and had got out of this current, which we found running to the southward at the rate of six miles per hour in the channel way, the wind freshened into a stiff gale from northeast, compelling us to heave the ship to under storm sails, and preventing our getting any observations for latitude and longitude for three consecutive days. [This being the case, we did not of course know where the ship was, only approximately.] The effect of the wind upon a ship lying to in this way, if uninfluenced by ocean currents, would be to drift or drive her to leeward in the direction the wind was blowing, at the rate of about thirty miles per day. At the expiration of three days, therefore, when the storm abated, and land was discovered to the westward, we thought it must be the Bashee Islands, which lie some hundred miles to the southward of Formosa; but on standing in we found it to be the northern end of this latter island, and that we had been actually carried during this time by a current, ninety miles to the northward against the wind or one hundred and eighty miles to the northward of where the ship would have been had there been no current, and near five hundred miles to the north of where she would have been, had she continued within the influence of the southerly current of the Formosa channel.

After determining our position on the chart, we stood to the eastward for the Loo Choo Islands, running across and out of this northerly current.

From Loo Choo our course was nearly due north to Nagasaki. In making this passage, we found that we again crossed the northerly current, but that there it was inclining a good deal to the eastward; and we ran out of it as we passed under the land of the Japan Islands. After accomplishing the object of our mission, we ran to the westward from Nagasaki to Shanghai, and thence down the Formosa channel to Hong Kong, carrying with us the strong

southerly current before spoken of, although by this time the northeast monsoon had materially abated. In the following summer the Preble was ordered back to California.

The monsoon had then changed, and the wind was from southwest. Yet we found the current still setting down the Formosa channel, and on passing the south end of Formosa, we again fell at once into the current setting to the northward, but which we found curved gradually to the eastward with us, as we pursued our course on the arc of a great circle in that direction. This course, however, we were obliged to abandon about lat. 35 deg. N. long. 145 deg. E., owing to a malignant epidemic that had broken out in the ship, and which was aggravated by the fogs and mists that overhung the current.

The experience of this cruise confirmed the existence of two powerful currents which, in a general way, were known to vessels cruising or trading in those seas, and which had been briefly noticed by writers upon the subject: but in what way, if at all, they formed a part of the great oceanic, or inter-oceanic circulation, was not known, and they consequently formed a bewildering subject to those who had to encounter them; particularly, as it was also known that, only a few miles to the southward of the south end of Formosa, the great equatorial current poured its immense volume into the China Sea, almost *directly at right angles to both of these currents just spoken of.* And this illustration of their constant flow in fixed and opposite directions, regardless of winds or seasons, their great velocity and their juxtaposition, were calculated to make a strong impression upon the mind, and set it to work to find out their origin and whither they led.

Sailing again for China and Japan in 1852, in the expedition under Commodore Perry, I had fortunately assigned to me such subjects, for scientific and professional investigation, as enabled me to have such instructions issued to the various vessels of the squadron as would insure their keeping very accurate and full meterological records.

After our return to the United States, I was detailed to assist Lieut. W. L. Maury to prepare for publication the charts and sailing directions of the surveys made by the expedition: and these records were placed in my hands for the purpose of tracing out, as far as possible, the location, direction and force of the currents in that part of the Pacific and adjacent seas, lying within the cruising grounds of the squadron.

The result of this work was the discovery of the fact that these currents formed a part of the great system in the Pacific, identical in all its essential features with that of the equatorial current, Gulf Stream, and counter current in the Atlantic, as will be seen by referring to my report on the "Kuro-Siwo," in the second volume of the Japan expedition report.

The development of these facts, as the data were placed in available form upon the chart, created no small degree of surprise and gratification: and naturally led to reflection and inquiry as to where these *counter currents* of the Gulf Stream and Kuro-Siwo had their origin, and how far their compensating influences kept up the equilibrium of the waters of the ocean. The prominent features of the subject, as it presented itself to the mind, were very marked, and, as before observed, were identical in almost all their parts in both the Atlantic and Pacific Oceans.

Here were the two great currents of the world, one in each of these oceans, running to the westward along the Equator, and known as the equatorial currents.

That in the Atlantic, after mostly passing into the Gulf of Mexico and finding no other outlet, has its whole volume forced out to the eastward along the north side of Cuba, until passing the southern extremity of Florida, where it is deflected sharp to the northward, along and not far distant from the coast of the United States, and forming the Gulf Stream; whilst that in the Pacific, in great part passing through the Polynesian Islands and China sea, has a *large shaving*—as it were—torn off its northern side by the south end of Formosa, which, with its momentum condensed, is thrown, like the Gulf Stream, with increased velocity short to the northward and forming the Kuro-Siwo. These two currents, obeying certain physical laws, bend gradually to the eastward as they proceed north; but meeting with local obstructions in the continents and islands that lie in their paths, are in great part turned to the southward, the one along the west coast of Europe, and the other along the west coast of America; ameliorating the climates of both these faces of the two continents by their genial warmth, and finally falling again into the currents of the Equator. Portions of both of these streams, however, pursue their courses to the northward and eastward into the Arctic ocean; that from the Gulf Stream going by the way of Spitzbergen, and that from the Kuro-Siwo by Behring's Straits. The accumulation of water about the Pole, from these two offshoots, must of course have an outlet somewhere; and it is here that we find the origin of the counter-currents in question—in the hyperborean currents that drain off this excess of water about the Pole. The first, finding in its way through the passages and channels leading from the Arctic Ocean into Baffin Bay and Davis Straits, runs thence down the coast of Labrador, and wedges itself in between the Gulf Stream and the coast of the United States, making the counter-current to the Gulf Stream. The second, finding but a narrow passage at Behring's Straits, is, by its greater specific gravity, forced under the warm water flowing to the north through these Straits, and reappears at the surface again on the coast of Kamschatka, and passes thence down the Japan sea and Formosa channel into the China sea, forming the counter-current to the Kuro-Siwo. There is also a third current, which flows to the southward along the east coast of Greenland, and which bears in its embraces the largest of the icebergs that are seen in the North Atlantic, and which underruns the Gulf Stream as the latter crosses the Atlantic. The Spitzbergen current, flowing to the northward and eastward, with an open sea far to the northward of the White sea, has been explored by early navigators; whilst that to the northward and eastward of Behring's Straits is known to our whalers, as shown by the statements of the captain of one of them, whom I have mentioned as having met at the Sandwich Islands, and which was subsequently confirmed by the explorations of Commander John Rogers, of the United States North Pacific Exploring expedition, in 1854, and 1855, who penetrated to the north of Behring's Straits in search of Herald Islands—reported by a British officer as lying to the northward and westward of those Straits. The island was not found, but an icy barrier was encountered in that direction

(N. W.); but as far as he went to northward and eastward beyond the Straits, he informed me, he *had an open sea, with a current flowing to the northward and eastward, and with a temperature of the water much above that due to the latitude.* Now, when we examine the effect of these currents upon the climates of the regions of the earth over and near which they pass, and compare the one with the other, we find that Lisbon, with the genial climate of Pensacola, is in the same latitude as Philadelphia; and London, with the climate of Norfolk, is in the latitude of 52 degrees north—whilst the same marked isothermal difference characterizes the opposite shores of the North Pacific; the temperatures of Europe and the west coast of America being raised by the influence of the warm waters of the Gulf Stream and Kuro-Siwo far above that due to the latitude, and the east coasts of the United States and Asia being correspondingly depressed by the hyperborean currents by which they are washed.

So long as these currents or streams are *troughed* or bedded in the ocean, they radiate or diffuse but little heat beyond their own limits, as shown by the thermometric diagrams accompanying my reports on the Kuro-Siwo, [2d vol. Japan Ex. Reports,] where it will be seen that the change in both water and air is abrupt upon entering or leaving the stream; and also, in a more familiar and striking manner, by a general comparison of their effects upon the continents: for we find that neither the Gulf Stream nor Kuro-Siwo exercise any appreciable ameliorating effect upon the climate of the United States and east face of Asia, although these currents lie but a short distance off the coasts; but as soon as they impinge upon and wash the shores of Europe and Oregon and California, they give out heat enough to change the climate of half of both the continents; whilst the cold currents bringing their frigid temperature from the Arctic ocean, and intervening between the Gulf Stream and the United States in the one case, and the Kuro-Siwo and Asia in the other, give climatic rigor to the coasts they wash.

Now, since these streams possess such a wonderful power of retaining their heat, so long as they do not touch the land, as to raise the climatic temperature 30 or 40 degrees over half a continent lying eight thousand miles distant from the points in the Tropics from whence they spring, and from which they derive their heat, it does not seem unreasonable to believe that those portions of the streams which pursue their courses direct into the Arctic Ocean, carry with them warmth enough not only to dissolve the ice they encounter, and keep their pathways open all through the year, but also, to raise the temperature permanently above the freezing point of a large area of the sea around the Pole, and thus prevent this extremity of the earth becoming locked in eternal ice, and overburdened, in the lapse of ages, with the accumulations of snow precipitated from the winds, loaded with moisture taken up by evaporation, and carried thence from more southern and warmer regions of the earth's surface. I am of the opinion that the open sea seen by Dr. Kane's expedition in 81 deg. north latitude, with a temperature of the water of 36 deg. (whilst a hundred and twenty miles to the south the thermometer was 60 deg. below zero), was the southern shore of this open sea that I suppose to exist about the Pole.

Dr. Kane called at my office in New York after his return from this ex-

pedition, in 1856, when I had just finished my work on the Kuro-Siwo, and I suggested to him that the open sea discovered by him most likely owed its existence to the Gulf Stream and Kuro-Siwo. He seemed impressed by the facts presented to him, and in his narrative, vol. 1. p. 309, when discussing the probable causes of this open sea, he not only admits the possibility of such being the case, but speaks of it as being altogether likely.

Since writing the foregoing, I have, by a singular coincidence, this morning received a periodical from Messrs. Richardson & Co., publishers, No. 4 Bond street, New York, which contains an article by M. F. Maury, LL. D., on "Russian America—its Physical Geography," that so strongly corroborates the ground-work of my hypothesis, that I cannot do better than to append it entire as a part of this communication, feeling that my own crude ideas, so indifferently expressed, only borrow a character, from this accidental indorsement, that they would not have otherwise possessed. I learn also (from newspaper telegram) that a private yacht sailed during the past summer for the Pole, by the way of Spitzbergen. She is on the right track, and if she is a steamer, and follows the water thermometer rather than the compass, she will most likely accomplish her object; and her return may be looked for any day this month or next.

In conclusion, I have merely to say: if my theory proves unworthy the consideration of your learned association, why, there the matter will most probably end; but if it is correct, then I hope my humble suggestions may, in God's Providence, be the means of averting the recurrence of some of the sad calamities that have attended former expeditions, and perhaps facilitate the solution of the great geographical problem which has so long occupied the attention of men of science.

With renewed assurances of the unaffected diffidence with which I have ventured to write you on this subject, I am, very respectfully,

Your obedient servant,

SILAS BENT.

P. S.—I send also a skeleton chart of the Northern hemisphere, with the warm currents traced in red, and the cold currents in blue.

MR. DALY'S REPLY.

[Copy.]

AMERICAN GEOGRAPHICAL AND STATISTICAL SOCIETY, NEW YORK, Oct. 8, 1868.

DEAR SIR:—I beg leave to acknowledge the receipt of your communication. I have read it with a great deal of interest, and will place it before the Society at the earliest possible opportunity.

The yacht to which you refer, that attempted the passage by the Spitzbergen route, has returned to Bergen, but we are not advised of the cause.

I will see that you are duly advised of the opinion expressed upon your paper.

Very truly yours,

CHAS. P. DALY.

SILAS BENT, Esq.

DIGRESSION—CLIMATIC INFLUENCE OF OCEAN CURRENTS.

Encouraged by this very polite note, I sent Mr. Daly another communication, which I will read after a short digression.

If you will pardon the interruption, I will here say that when contemplating this chart, with all these great currents of the ocean made apparent to the eye at one glance, and recalling to mind the climates, as I have experienced them, in almost every portion of the earth bordering upon the oceans between the latitudes of 60 deg. north and south, I cannot divest myself of the conviction that *all countries so situated derive their climatic character*—whenever that differs from what is due to the latitude—*entirely from the ocean currents that wash their coasts, and not at all from those which, though flowing near them, do not touch their shores.* To show you the grounds upon which I base this conclusion, I will ocupy your attention for a few moments whilst I endeavor to lay them before you. We will start with what is known as the Humboldt current, which, coming from the Antarctic ocean, and possibly splitting on Cape Horn, flows with its greatest volume to the northward along the whole west coast of South America. The climate there is cool, and as you approach the Equator the temperature is so much below what is due to the latitude, that at Lima, in 12 deg. south latitude, woolen clothing is necessary for comfort during several months of the year, and the heat is never oppressive. The common belief is that this is owing to the close proximity of the Andes; but, as like causes produce like effects, if this were the case the Sierra Nevada, which lies almost as near to the coasts of California and Mexico as the Andes do to those of Chili and Peru, would give similar cool climates to those countries; but this they do not possess, for on the contrary they have warm climates, derived, as before stated, from the influence of the Kuro-Siwo. The Kuro-Siwo, from having been in contact with the land in high latitudes, which robbed it freely of its warmth, reaches the equatorial belt with a comparatively low temperature, but still not so low as that of the Humboldt current from the South; consequently we find the Sandwich Islands, in 22 deg. north latitude, with very nearly the same climate as the Marquesas group, lying only ten degrees south of the equator—both being within the immediate region of confluence of these two streams, where they form the great equatorial current of the Pacific; and these Islands stand unrivaled in their delightful climates by any other spots on the earth's surface. We will now start west with the equatorial current, the waters of which are but just brought under the direct rays of the sun, from which they continue to *accumulate* heat so long as they remain within the tropics.

ACCUMULATIVE HEAT.

We come first to the Ladrone Islands, which have a much warmer climate than the two groups just spoken of; then to the Philippine Islands, where the heat is quite oppressive even in winter, but which increases in fervor as we reach Malacca—is all aglow in India, and becomes stifling in its intensity as these waters, after traveling fifteen thousand miles, and being fully three hundred days under a vertical sun, are thrown against the eastern shores of Africa. Here this current is deflected to the southward to the Cape of Good

Hope, from whence it starts with its burden of heat to keep an "open sea" about the South Pole. It does not double round this Cape and flow to the northward on the west coast of Africa, as stated by Dr. Hayes, in his paper recently read before the Geographical Society of New York, and of which I shall have occasion to speak again presently,—although there is a current there running in that direction, for Sir James Ross, in 1842, discovered that these were two distinct currents: that to the east of the Cape, flowing south, being a hot current from the tropics, as just described, whilst that to the west of the Cape flowing north is a cold Antarctic current; and this has been confirmed by more recent observations, taken at the instigation of Admiral Maury: and also—to my mind—by the marked difference of climate found on this west coast, compared with that we have just left on the east side of Africa. This Polar current continues north until reaching the Torrid Zone and meeting the reflux of the Gulf Stream, when the two uniting, form the equatorial current of the Atlantic. Du Chaillu, in his work on Africa, gives the mean temperature in latitude 1 degree 30 south, from October to June, and embracing the warmest part of the year, as 77 degrees—the highest range being 88 degrees, and the lowest 66 degrees. These observations extended from the coast two thousand miles inland. This charming climate, directly under the Equator, is, I am satisfied, owing to this current from the South.

Now, continuing west again from this point some two thousand miles, brings us to Brazil, with its fervid climate; but as the waters of the equatorial current, when reaching there, have been comparatively but a short time directly under the sun, the thermometer shows no such intense heat as that on the east coast of Africa. This current now dividing on Cape St. Roque, the larger portion flows into the Carribean Sea and Gulf of Mexico, to form the Gulf Stream; whilst the other is deflected south, and gives a so much milder climate to the east coast of South America than we found on the west, that cattle, which run wild on the Falkland Islands, in latitude 52 degrees south, subsist by grazing all the year round.

CURRENT AT CAPE HORN.

We now come to Cape Horn. And here again, Dr. Hayes, probably misled by some of the standard atlases, has fallen into another error in supposing this current to double round the Cape, and form the Humboldt current first referred to in this digression, for the water thermometer tells a different story; and, as an additional proof that the Humboldt current comes from the Antarctic Ocean, I have myself seen an iceberg brought by this current to 60 degrees south latitude, which, in size, was far beyond any I have ever seen described in the northern seas; and, on one occasion, in passing from the Atlantic to the Pacific, in one of the finest frigates in the navy, we were twenty-one days beating and struggling against this current and the wind, before we doubled the Cape; and on another I was a fortnight before we thought it safe to stretch away into the Pacific, and both times ran as far as 60 degrees south latitude. In the absence, therefore, of more positive data than I have here given, I think it not unreasonable to believe that the same phenomenon of currents will be found to exist here, that has been described at the Cape of Good Hope; and that whilst the Humboldt current

comes from the Antarctic Ocean, and flows north along the west coast of South America, the warm branch of the equatorial current of the Atlantic, which we have followed down the east coast from Brazil, continues its course to the southward and eastward into the South Polar Sea. But, whether the Humboldt current is a recurvation of the Australian Stream, or comes from the inter-Polar Ocean, we have no data to determine.

The same general system of currents, I am satisfied, will be found to exist in the Southern Hemisphere, that has been described in the Northern; modified, of course, to conform to the widely different geographical character of the southern extremity of the earth from that of the northern. In crossing over from the south side of Australia to New Zealand, Sir James Ross found the Australian Stream to be three hundred miles in width at that point, with a high temperature, and setting strongly to the southward and eastward. Vessels bound from Australia to Cape Horn, or from the Cape of Good Hope to Australia, keep well to the southward, about the parallel of 50 degrees, in order to avail themselves of the eastwardly currents known to be there, and which, I have no doubt, are the recurvations of the Australian and Good Hope Streams; they, like the Gulf Stream and Kuro-Siwo, throwing only small portions of their volume into the Polar Sea, whilst the larger mass recurves and falls again into the equatorial currents on the opposite sides of the oceans from whence they spring.

THE CLIMATE OF ITALY.

Of the oceanic coasts of the northern hemisphere I have before spoken, but not of those of the Mediterranean, and to which I will now call your attention. Naples, in Southern Italy, is in the same latitude as New York and Genoa, and Marseilles about the same parallel as Toronto—yet, at Genoa I have plucked ripe oranges from the tree early in February, and Naples has even a much more vernal climate. This is attributed to the warm winds from Africa; but, as you will observe, these winds have to cross the Mediterranean at its widest part, a distance of more than three hundred miles. Now, if the winds have such influence as this, why should not those from the perpetual snows of the Alps give a severe climate to the plains of France and Italy, which lie directly at their feet and not fifty miles from this snow? Yet these plains, in the latitude of Maine, are verdant with a perennial summer. The winds, therefore, are not the agencies that produce this, but rather the warm waters of the Gulf Stream, which, as a surface current, flows constantly into the Mediterranean through the Straits of Gibralter, and with such velocity too, that when the wind is from the westward, sailing vessels are unable, sometimes for weeks together, to pass out into the Atlantic. But, even admit that the winds from Africa are the cause, then whence does northern Africa, with its latitude of 34 degrees north, obtain such an excess of heat, as to be able to throw off enough across the whole width of the Mediterranean to change so materially the climate of such an immense region as this? It cannot be derived directly from the sun, for Du Chaillu, as before shown, found a lower average of temperature within one degree of the Equator than is enjoyed in Italy. But, it may be said, northern Africa being a desert, will account for its being so much hotter than the region visited by Du

Chaillu. This, no doubt, has its effect, but not to the extent necessary to produce such results; for I have been in this desert, and also in the jungles of Ceylon and India, where the rank growth of vegetation was so dense that the sun's rays never reached the soil, yet the latter were hotter than the former, because, as before shown, the waters of the Indian Ocean are hotter than those of the Mediterranean. The latter, however, are sufficiently warm, when bathing the shores of Spain, France and Italy, to diffuse heat enough to give them the delicious tropical climates they enjoy.

INTERNATIONAL IMPORTANCE OF THE THEORY.

Pursuing these reflections, this matter presents a phase of international importance which, were it not for the inhumanity of possessing such a power, might place the whole of Europe at the mercy of this country. For, admitting that Europe derives its mild climate from the Gulf Stream, which no one now, I believe, disputes, then to divert this stream from its present direction, would be to bring the whole of Europe at once, so to speak, to its normal climatic condition: that is, France and Austria would have the climate of Canada; and England, Germany, and Northern Europe would become a frozen wilderness, such as British America and Labrador. To accomplish this, the possession of the Isthmus of Panama, and the expenditure of two or three hundred millions of dollars in the excavation of a sufficient width and depth of the rock only, that intervenes between the Carribean Sea and the Pacific, and the opening of a small sluice through the soil, to afford a beginning for the passage of the water from ocean to ocean—and but a short time would probably elapse before the channel would be large enough to give a new outlet to the equatorial waters of the Atlantic, and thus cut off that excess which now goes to make the Gulf Stream.

SECOND LETTER TO MR. DALY.

2020 Olive Street, St. Louis, Oct. 12, 1868.

Chas. P. Daly, Esq., President American Geographical and Statistical Society, New York:

Dear Sir: Your kind favor of the 8th instant is received, and I pray you to accept my cordial acknowledgements for your courteous attention. I am much gratified to learn that my communication has been found by you worthy of being submitted to your Society.

I shall watch with interest for accounts of the causes of failure in the recent attempt of the yacht to reach the Pole by the way of Spitzbergen, though I expect to hear that—like Parry and other explorers—she endeavored to steer [illegible] North after getting to the eastward of Spitzbergen, instead of keeping on to the northward and *eastward*, along the path of the Gulf Stream, until getting fully into the open sea. This was the mistake made by Parry in 1827, who crossed the warm current of the Gulf Stream, setting strongly to the north-east before reaching Spitzbergen: and, after getting to the northward of these islands, he fought persistently against the south-eastwardly set of the hyperborean current, which he then fell in with, and which, if followed, would have carried him back into the Gulf Stream, and perhaps given him a

much better chance of accomplishing his object with his ship than he found in his sledge boats; for, on his return to his ship, after his failure with the boats and sledges, he found, to his surprise, the sea all open to the northward and eastward, and apparently affording, in his opinion—as expressed in his narrative—access for his ship to as high a latitude in that direction as he had reached in his laborious journey over the ice.

In my former communication, my hypothesis that the Gulf Stream and Kuro-Siwo keep pathways open at all seasons to the Pole, should perhaps be qualified with an exception as to the early summer, when icebergs and field ice are both doubtless driven by the winds and counter currents well into, if not across, these streams, as they are into the Gulf Stream in the North Atlantic, and interrupting, in this way, a free passage for the time being, but which never form a permanent or solid ice barrier across these streams. On that account, it may be that the summer is not the best season for making the attempt to reach the open sea; but that the early spring, before the ice is detached from its winter fastenings, is the time best calculated for success. That there is an open sea, with a temperature permanently above the freezing point, surrounding the North Pole (and the South Pole, too, for that matter), I have no doubt.

If this is the case, to reach the Pole, then, it must be done in ships; and the only avenues by which they can enter this Polar Sea is by following the Gulf Stream or Kuro-Siwo in their north-eastwardly courses to that sea. These afford the only accessible channels or gateways through the ice surrounding this sea; and to find and to follow these the water thermometer is the only guide. Nor must the surface temperature be wholly relied upon; for Captain Rodgers—whom I have before spoken of—mentioned to me the remarkable fact that north-east of Behrings Straits he found the water lying in layers of temperature: first a cool, then a warm, and beneath that a cold stratum of water.

For a time I was at a loss to account for this; but, upon subsequent reflection, it occurred to me that this was a natural arrangement of waters of different specific gravities: that of the lowest temperature, being the densest, clings to the bottom; the warmest water, from the salt it contains, being next in weight, overlies the first; and then the cool, fresh water, formed by the dissolution of the ice, floats on the surface, and is carried with and becomes a part of the current immediately underlying it.

This arrangement seems, too, to be a wise provision of nature, by which the warm current is insulated, as it were, to prevent too great a loss of its temperature whilst passing the region of ice; but which, after reaching the open sea, and, having by that time warmed the water above it, spreads out, whilst at rest for a time about the Pole, and throws off, by the atmosphere, much of its warmth before starting on its return course to the South again.

So it will be seen that a submarine temperature, by the use of Six's thermometer, should be taken, as well as the surface temperature, whenever the latter is not above that of the atmosphere.

With renewed thanks for your goodness, I remain, very respectfully, your obedient servant,

SILAS BENT.

COMMENTS ON THE FACTS.

The yacht referred to in these letters proved to be the "Germania," of Bremen; and, as I apprehended, she *did* try to go directly north from Spitzbergen; and, when she encountered the ice, instead of following its trend to the eastward, she followed it to the westward: and finally, from latitude 80 deg. 30 min. north, in longitude 6 deg. 35 min. east, she found herself beaten back to latitude 73 deg. 23 min. north, longitude 17 deg. 30 min. west, before she got sight of the Greenland coast; then, turning to the north-east again, she was enabled to reach the latitude of 81 deg. 65 min. north, in longitude 16 deg. east, on the 14th of September; showing that the farther she receded from the path of the Gulf Stream, the more the ice was found to encroach to the southward: whilst the nearer she approached that path, the farther north she was enabled to get. But by this time the season was too far spent to admit of a longer prosecution of her voyage, and she was obliged to return, baffled in her enterprise. This last letter of mine to Mr. Daly has not been answered; but, on November 12th last, the distinguished explorer, Dr. Isaac J. Hayes, a member of the Geographical Society, delivered an address before that body on the "Progress of Arctic Discovery," in which he alluded to my communications; and, although he admits that the currents set to the northeast from Behring's Straits, and through the sea lying between the Spitzbergen and Norway, yet he says the ice is closely impacted in both of these directions: but upon what authority I am unable to discover. I am inclined to believe that my letters were referred to him by the President of the Society, and that he has failed to see the point or gist of my theory; for, in speaking of the Gulf Stream route, he said: "But the disastrous voyage of Willoughby caused the English to abandon the effort to penetrate in that quarter; and the Dutch, who succeeded them, in the unhappy Barentz, and the destruction of his ship, lost the bright hopes with which they had assumed the undertaking." The history of these voyages, however, shows that they were both undertaken in the interest of commerce, to discover a north-east passage from Europe to China—that of Willoughby in 1553, and that of Barentz in 1596; and that their mission was *not* toward the Pole further than the conformation of the north line of the continent might necessarily carry them; and, as they knew nothing of the Gulf Stream, its direction or influence, they clung to the coast, naturally supposing that the farther south they kept, the milder would be the climate. This led them down into the bight between Lapland and Nova Zembla, and entirely out of the genial influence of the Gulf Stream, where their ships were respectively frozen in, and where they and most of their crews miserably perished.

This, however, can hardly be called an attempt to *follow* the path of the Gulf Stream.

DOGMAS OF DR. HAYES.

The Doctor then disposes of the Behring's Straits route even more summarily and less satisfactorily, to my mind, than he does of that of the Gulf Stream; and, in advocacy of the route by Smith's Sound, which he has pursued on his former expeditions, and by which he reached the open Polar Sea, 'tis true, but only by traveling over the ice some hundred and fifty miles

beyond where his vessel was frozen in—he says: "And now let me assert one more dogma as part of the general proposition: A successful prosecution of this exploration must be in the direction against the current, and towards the point where the open water makes from the northward; where the land gives you holding ground; where the ice drifts past you; where hope lies ahead: where the enemy sets, not with you on your track, but behind you; where a field of ice once passed is rid of."

The Doctor shows himself a sanguine man, when he can draw such a hopeful picture, and lay down such an emphatic dogma, in the face of the thousands of lives, the millions upon millions of money, and the three hundred years of time, that have been spent in fruitless attempts to penetrate the ice-belt *against* the current, as he here proposes. But I think the prospect is not very encouraging for speedy success in that direction.

EXPERIENCE AND HYPOTHESIS.

Dr. Hayes' experience in his gallant explorations, however, is deserving of every consideration; and this I most cheerfully accord him. I have none to offer in support of my theory; for, although I have been to the regions of icebergs, both North and South, yet I have never been engaged in any Polar explorations. My views are purely hypothetical, but are based upon the operation of certain physical laws, the observation and study of which for near thirty years have taught me to read as I have now set them before you. Whether they are right or not, will be determined when, in the providence of Him who framed those laws, it becomes His will that this great geographical problem shall at last be solved.

And now, in conclusion, to sum up the points of my argument, to show their bearing upon my theory: I must beg to remind you of the comparison made between the circulation of the blood of the animal system, and that of the waters of the oceans—showing that the one is governed by laws as immutable and unvarying as that of the other; the marked resemblance between the Gulf Stream and the Kuro-Siwo—these two great arteries of the two great oceans of the world, the Atlantic and Pacific; that the greater portion of both these streams recurves on the opposite sides of the oceans to those from which they start, but that large portions of both of them continue their courses to the *north-east*, into the Arctic Ocean; that this north-east course is due to a physical law, which, continuing to operate upon these streams after getting beyond the land of the continents, keeps them on this course until, by the junction of their waters about the Pole, their motion is lost; that they refuse, from want of affinity, to mingle with the sea water through which they pass; that they give out and diffuse their heat freely when coming in contact with the land, but retain it in a wonderful manner so long as troughed or bedded in the oceans; that this heating power is so great, that, if concentrated from either stream, it would be capable of melting and keeping in flow a river of iron equal in volume to that of the Mississippi, and that they do actually change the climate of nearly one-quarter of the globe; that, whilst it is notoriously admitted by every geographer (and is so represented on all maps) that these streams are perfectly defined to the very threshold of the ice girdle

that surrounds the Polar Sea; that they assault that girdle in the oblique direction of their courses to the *north-east;* that they have been entirely delineated, and are easily traced, by the water thermometer; and yet, incredible as it may appear, it is nevertheless the fact, that I have not found a single instance on record in which any explorer has ever attempted *to trace and follow these streams through that ice!*

Now, I repeat my belief, that the North Pole has already been reached—that it was done in the seventeenth century, by the Dutch whalers before spoken of, and that they reached there by having unconsciously followed the path of the Gulf Stream; and I therefore reiterate the convictions expressed in my communications to the President of the Geographical Society: "*That the Gulf Stream and Kuro-Sivo are the prime and only cause of the open sea about the Pole, with its temperature so much above that due to the latitude:—that the only practicable avenues by which ships can reach that sea, and thence to the Pole, is by following the warm waters of these streams into that sea—that to find and follow these streams, the water thermometer is the only guide, and that for this reason they may be justly termed*" "THE THERMOMETRIC GATEWAYS TO THE POLE."

MR. BENT'S LECTURE.

From the Democrat of January 22, 1869

Mercantile Library Hall was quite well filled last evening by a very select audience, who listened for more than two hours to Captain Silas Bent's Lecture on the Open Polar Sea, which was replete with interest, and illustrated by gigantic diagrams. So clear, so conclusive, and so scientific an analysis of the thermometrical influence of the great oceanic currents has, perhaps, never been given, as that offered by our distinguished fellow-citizen; and their effect upon climates, and the polar region was shown so clearly that every one could comprehend. We gave a synopsis of the main points of the paper, when it was first read before the Historical Society, a few weeks since, and it has so permanent a value and so popular an adaptation that we shall report it in full in our Sunday morning's paper. Further notice now is therefore unnecessary.

THE LECTURE.

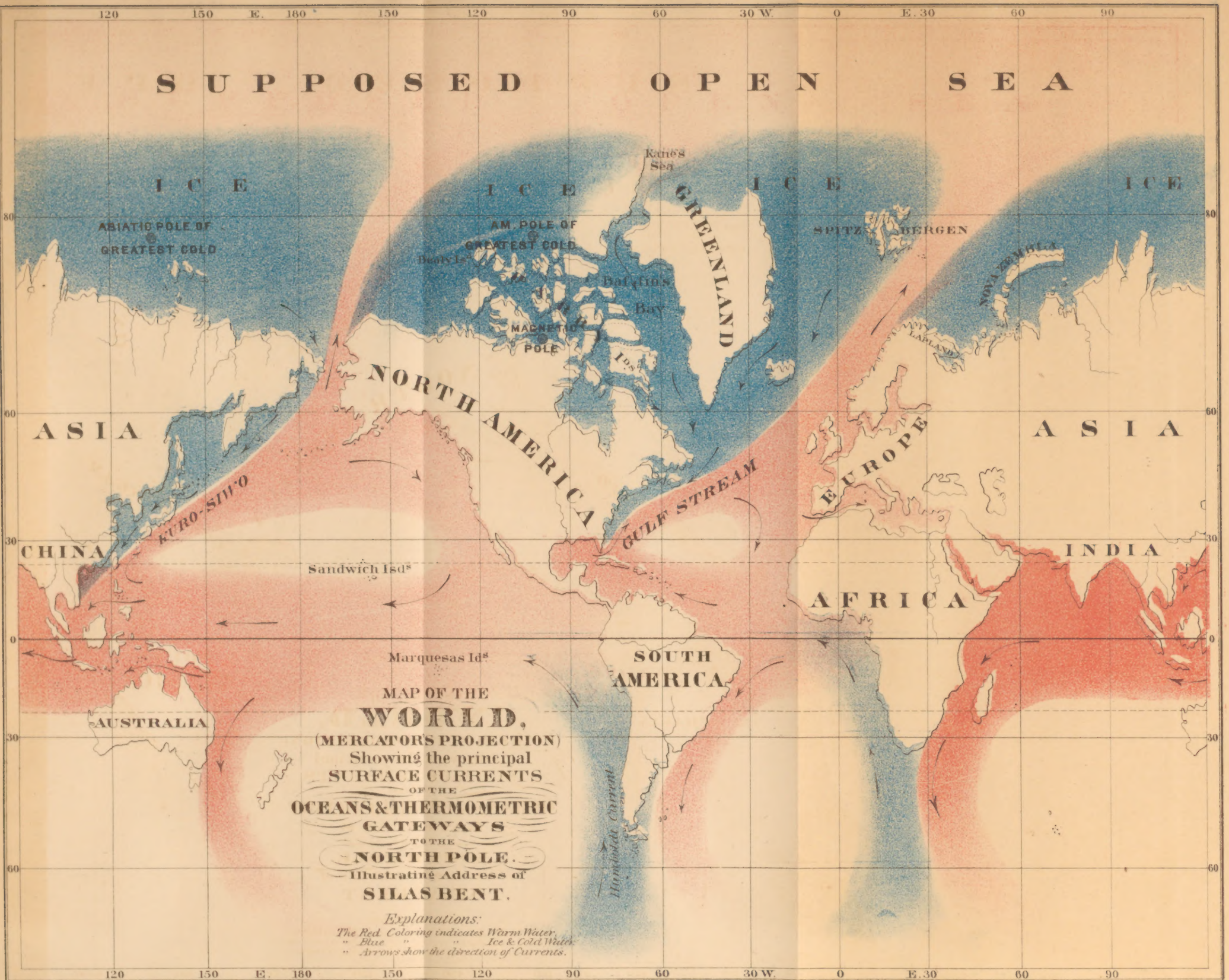
From the Republican of January 22, 1869.

A large and intelligent audience assembled in the Mercantile Library Hall last evening, to hear the lecture of Mr. Silas Bent on "Routes to the North Pole." It formed a most interesting entertainment. The delivery of Mr. Bent is animated and unrestrained, and his enunciation remarkably distinct. By the aid of a globe and various extensive maps, the lecturer illustrated his subject in a clear and simple manner, and accommodated it to the comprehension of all the spectators. The North Pole is invested with an exciting and, we might say, a romantic interest, and Mr. Bent's lecture is full of important facts respecting the mysteries of the region of ice, abounds in passages of graphic description, and presents a full history of the many attempts to solve the problem of the Northwest passage to India. The lecture is somewhat lengthy, but the attention of the audience was kept thoroughly alive.

CAPTAIN BENT'S LECTURE.

From the Dispatch of January 22, 1869.

A large and intelligent audience met at the Mercantile Library Hall last evening, to hear Captain Silas Bent's learned and interesting lecture on the Open Polar Sea. The lecture was as learned, clear and instructive a discourse as was ever delivered in the Hall. By the aid of astronomical and philosophic apparatus, the speaker so clearly demonstrated his meaning as to be well understood by all present. Some of the descriptions were very graphic, particularly when treating of the celebrated Gulf Stream, and of the Kuro-Siwo, or the Black Sea of the Japanese. The lecture lasted for about two hours, but was of so interesting a character and so well delivered that the attention of the audience was sustained until the close.



R. P. Studley & Co. lith. St. Louis.